REVIEW OF NMFS DRAFT BIOLOGICAL OPINION ON THE EFFECTS OF RUSSIAN RIVER FLOW REGULATION ON STEELHEAD, COHO SALMON, CHINOOK SALMON AND THEIR CRITICAL HABITAT

by

Richard A. Marston, Ph.D., P.H.
1214 Windsong Lane
Manhattan, KS 66503-7535

For

Center for Independent Experts (CIE)

Executive Summary

I was asked to read the NMFS Draft Biological Opinion (Draft BO) on the water supply, flood control, and channel maintenance operations (Project) conducted by the U.S. Army Corps of Engineers (Corps), the Sonoma County Water Agency (SCWA), and the Mendocino County Russian River Flood Control District in the Russian River Watershed. The cover letter for this report, with a stamped date of 11 June 2007, states that the "…draft Biological Opinion analyzes the effects of the proposed Project on Central California Coast (CCC) steelhead (Oncorhynchus mykiss), CCC coho salmon (O. kisutch), California Coastal (CC) Chinook salmon (O. tshawytscha), and their designated critical habitat in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). In the draft Biological Opinion, analyses are presented of the current operations of the Project for the next 10 years." The effects of alternative flow regulation regimes were not considered because of lack of information at this time. It was further stated that "Ten years is the most likely scenario to fully analyze and develop permits and water rights agreements/decisions that may affect flow changes in the Russian River and Dry Creek."

The main points of my review are:

1) The site specific data for the Russian River, referenced supporting literature, and analysis in the Draft BO provide reasonable support for the conclusion that the regulated elevated inflows and systematic artificial breaching of the Russian River estuary collectively cause an adverse effect on rearing habitat for steelhead in the lower Russian River (i.e., in the estuary/potential lagoon system)?

   I agree with the Draft BO (pages 200-201) that these impacts will have adverse effects on rearing habitat for steelhead. The best availability literature also supports the claims. The Project management during winter months are generally

beneficial, but the flow management during spring, summer and late fall will affect the availability of rearing habitat for steelhead. The quantity and quality of rearing habitat for Steelhead will be reduced because of the low flows and channel grading, which reduce habitat complexity (e.g., decreased large woody debris, disconnect between floodplain and channel), increase sediment input and create conditions that could strand juvenile salmonids. The Draft BO does an adequate job of identifying the Primary Constituent Elements (PCE) of critical habitat for the three species.

2. The Draft BO gives adequate attention to the factors affecting the relative productivity of freshwater lagoons and estuaries and the use of freshwater lagoons by steelhead and other salmonids. The key variables appear to be stratification of salinity and temperature, which in turn affect dissolved oxygen. The Draft BO cites the work of Smith (1990), and SCWA (2006a, 2006b). I conducted a literature search, using the Elsevier SCOPUS search engine and the keywords: California, estuary, geomorphology, hydrology. My search returned 3,777 entries. Another search using keywords "California, estuary, salmonids" identified a pertinent article (that was not cited in the Draft BO) in the *Transactions of the American Fisheries Society* by Quinones and Mulligan (2005) on habitat use by juvenile salmonids in the Smith River estuary. The study demonstrated that riparian vegetation may be an essential component of juvenile salmonid rearing habitat in estuaries with little instream cover. In my judgment, the Draft BO could do a more thorough job reviewing the literature concerning the hydrology and geomorphology of estuaries, but does a reasonable job of covering the literature on salmonid productivity in estuaries, aside from missing the citation previously mentioned.

3. The Draft BO states on page 172 that the "systematic breaching of the estuarine bar reduces the estuary's carrying capacity for juvenile steelhead". Is this a reasonable and adequately supported statement?

   The effects of estuary management are discussed on pages 163-175 of the Draft BO. The Draft BO does a reasonable job of reviewing the relevant literature, in my opinion. I agree with the studies by SCWA (2006a, 2006b) and Smith (1990) that summertime artificial breaching of sandbars impairs water quality because salinity stratification leads to periods of higher water temperatures and low dissolved oxygen levels. The Project would maintain a closed lagoon in the low-flow summer which would stabilize salinity and dissolved oxygen conditions, and increase and stabilize the invertebrate food base for salmonids. Breaching should be scheduled in spring or fall, but should avoid summer.

4. As noted in Attachment A, "Information on estuarine use and population dynamics of steelhead and other salmonids in Mediterranean climates is very limited…Most published information on steelhead is from more northerly regions where year-round rainfall supports high summer flows and rearing habitat in upland watersheds." I could not identify uncertainties related to the estuarine

analysis that were not addressed in the Draft BO that might affect the BO substantively. However, it will remain difficult to separate the effects of the Project on salmonids from the effects of other human activities in the Russian River watershed that are identified in the Draft BO: hatchery operations, river channelization, channel maintenance (sediment removal, debris clearing, vegetation removal, bank stabilization), wastewater treatment, agriculture, urban development, instream road crossings, small dams, gravel extraction, timber harvest, water diversions, river restoration. Moreover, natural events (drought, slope failures, floods, ocean productivity and predation) and atmospheric warming are also discussed in terms of adversely affecting salmonids. Some non-Project impacts will even date from events that occurred in the watershed in the late 1800s and early 1900s, as observed also in the Mattole, Navarro and Albion river estuaries (Zedonis 1992, Cannata 1998, Maahs and Cannata 1998)). The cumulative effect of these activities has greatly reduced salmonids in CCC streams, so the predicted impacts described in the Draft BO are reasonable, but one must recognize that a large degree of uncertainty exists because the future cumulative impacts are difficult to predict.

Background

The purpose of this independent review is to evaluate and comment on the use of the best available scientific and commercial information in the estuarine-related analysis of the draft (dated June 11, 2007) Biological Opinion (BO) for the Russian River Water Supply and Flood Control Project. It is hoped that this review will help ensure that the best available information is used in this biological opinion. The review will focus on the technical aspects of the estuarine-related portions of the NMFS draft biological opinion; the review will not determine if NMFS conclusions regarding the project's potential to adversely modify critical habitat or jeopardize the continued existence or recovery of listed salmonids are correct.

The Southern and Central Coastal sections of California have a Mediterranean climate that significantly affects physical and water quality dynamics of estuaries. A combination of ocean wave action and the absence of significant rainfall between late May and early November contribute to the formation of closed, freshwater lagoons at river mouths. Wave action builds up sandbars at river mouths; low summer inflow to the lagoons percolate through the bar, thus maintaining closed freshwater systems. Limited research indicates that, in this region where summer flows in headwaters are naturally very low, freshwater lagoons provide highly productive and important rearing habitats for steelhead (*Oncorhynchus mykiss*) and possibly Chinook salmon (*O. tshawytscha*).

The ongoing and proposed operations of the Russian River reservoirs cause sustained, unnaturally high flows to the estuary from approximately May through early November. During this period, the elevated flows can cause natural bar breaching at the river's mouth, with resulting water quality cycles that can be deleterious to juvenile salmonids. The elevated summer inflows also contribute to high water surface elevations that threaten to flood a few properties bordering the Russian River estuary. Project operators

address the potential threat of property flooding by breaching bars that form at the river's mouth, thereby maintaining the estuary as an open system with nearly marine conditions in the middle and lower segments of the system.

In conducting Section 7 consultations, NMFS is obligated to use the best scientific and commercial data available to evaluate whether projects jeopardize the continued existence of species listed under the Endangered Species Act. However, for such analyses, NMFS is not obligated to independently develop new scientific data. NMFS Draft BO for the Russian River Water Supply and Flood Control Project reviewed scientific literature concerned with the role of small estuaries and freshwater lagoons as rearing habitat for steelhead. Information on estuarine use and population dynamics of steelhead and other salmonids in Mediterranean climates is very limited; most is from unpublished manuscripts and graduate theses. Most published information on steelhead use of estuaries is based on populations from more northerly regions where year-round rainfall supports relatively high summer flows and rearing habitat in upland watersheds. NMFS Draft BO directly addresses estuarine issues in three separate sections: the Baseline (Section V., pp 82-83, 92-94, 98, and 102), the Effects (Section VI.G), and the Integration and Synthesis (Sections VIII.A.2, and VIII. B.2).

Description of Review Activities

The following tasks were assigned and completed.

1. Read the draft Russian River Biological Opinion with a focus on the estuarine component of the analysis.

2. Consider additional scientific information as necessary. I reviewed the literature that was provided by the Center for Independent Experts (CIE) (Appendix A1), as well as literature I had reviewed for a previous, closely related CIE review concerning assessment of California Northern Coast salmon (Appendix A2).

3. No later than February 15, 2008, each CIE reviewer shall submit their independent peer-review report addressing each task in this Statement of Work to Dr. David Die at ddie@rsmas.miami.edu and Mr. Manoj Shivlani at mshivlani@rsmas.miami.edu. My report was submitted 3 March 2008, delayed because of family cancer issues that arose after I had accepted the project.

I was asked to respond to the following questions:

1) Does the site specific data for the Russian River, referenced supporting literature, and analysis in the Draft BO provide reasonable support for the conclusion that the regulated elevated inflows and systematic artificial breaching of the Russian River estuary collectively cause an adverse effect on rearing habitat for steelhead in the lower Russian River (i.e., in the estuary/potential lagoon system)?

2) Were relevant published and unpublished studies on the relative productivity of freshwater lagoons and estuaries and the use of freshwater lagoons by steelhead and other salmonids missed? If so, what key studies were missed?

3) The Draft BO states on page 172 that the "systematic breaching of the estuarine bar reduces the estuary's carrying capacity for juvenile steelhead". Is this a reasonable and adequately supported statement?

4) What uncertainties related to the estuarine analysis were not addressed that might affect the BO substantively?

Summary of Analyses and Comments

My response to each of the four assigned questions is presented below.

1. Yes, the site specific data for the Russian River, referenced supporting literature, and analysis in the Draft BO provide reasonable support for the conclusion that the regulated elevated inflows and systematic artificial breaching of the Russian River estuary collectively cause an adverse effect on rearing habitat for steelhead in the lower Russian River (i.e., in the estuary/potential lagoon system)?

   I agree with the Draft BO (pages 200-201) that these impacts will have adverse effects on rearing habitat for steelhead. The best availability literature also supports the claims. The Project management during winter months are generally beneficial, but the flow management during spring, summer and late fall will affect the availability of rearing habitat for steelhead. The quantity and quality of rearing habitat for Steelhead will be reduced because of the low flows and channel grading, which reduce habitat complexity (e.g., decreased large woody debris, disconnect between floodplain and channel), increase sediment input and create conditions that could strand juvenile salmonids. The Draft BO does an adequate job of identifying the Primary Constituent Elements (PCE) of critical habitat for the three species.

2. The Draft BO gives adequate attention to the factors affecting the relative productivity of freshwater lagoons and estuaries and the use of freshwater lagoons by steelhead and other salmonids. The article by Thorpe (1994) is an especially concise summary of factors affecting estuarine productivity. The number of published studies on this topic is limited. The key variables appear to be stratification of salinity and temperature, which in turn affect dissolved oxygen. The Draft BO cites the work of Smith (1990), and SCWA (2006a, 2006b). I conducted a literature search, using the Elsevier SCOPUS search engine and the keywords: California, estuary, geomorphology, hydrology. My search returned 3,777 entries. Another search using keywords “California, estuary, salmonids” identified a pertinent article (that was not cited in the Draft BO) in the *Transactions of the American Fisheries Society* by Quinones and Mulligan (2005)

on habitat use by juvenile salmonids in the Smith River estuary. The study demonstrated that riparian vegetation may be an essential component of juvenile salmonid rearing habitat in estuaries with little instream cover. Although the literature review in the Draft BO is not exhaustive, I believe proper emphasis has been given to the critical factors in estuarine hydrology and geomorphology. The Draft BO does an adequate job of covering the literature on salmonid productivity in estuaries, aside from missing the citation previously mentioned.

3. The Draft BO states on page 172 that the "systematic breaching of the estuarine bar reduces the estuary's carrying capacity for juvenile steelhead". Is this a reasonable and adequately supported statement?

   The effects of estuary management are discussed on pages 163-175 of the Draft BO. The Draft BO does a reasonable job of reviewing the relevant literature, in my opinion. I agree with the studies by SCWA (2006a, 2006b) and Smith (1990 that summertime artificial breaching of sandbars impairs water quality because salinity stratification leads to periods of higher water temperatures and low dissolved oxygen levels. The Project would maintain a closed lagoon in the low-flow summer which would stabilize salinity and dissolved oxygen conditions, and increase and stabilize the invertebrate food base for salmonids. Breaching should be scheduled in spring or fall, but avoid summer.

4. As noted in Attachment A, "Information on estuarine use and population dynamics of steelhead and other salmonids in Mediterranean climates is very limited…Most published information on steelhead is from more northerly regions where year-round rainfall supports high summer flows and rearing habitat in upland watersheds." I could not identify uncertainties related to the estuarine analysis that were not addressed in the Draft BO that might affect the BO substantively. However, it will remain difficult to separate the effects of the Project on salmonids from the effects of other human activities in the Russian River watershed that are identified in the Draft BO: hatchery operations, river channelization, channel maintenance (sediment removal, debris clearing, vegetation removal, bank stabilization), wastewater treatment, agriculture, urban development, Instream road crossings, small dams, gravel extraction, timber harvest, water diversions, river restoration. Moreover, natural events (drought, slope failures, floods, ocean productivity and predation) and atmospheric warming are also discussed in terms of adversely affecting salmonids. Some non-Project impacts will even date from events that occurred in the watershed in the late 1800s and early 1900s, as observed also in the Mattole, Navarro and Albion river estuaries (Zedonis 1992, Cannata 1998, Maahs and Cannata 1998)). The cumulative effect of these activities has greatly reduced salmonids in CCC streams, so the predicted impacts described in the Draft BO are reasonable, but one must recognize that a large degree of uncertainty exists because the future cumulative impacts are difficult to predict.

Conclusions

I congratulate the U.S. Army Corps of Engineers for producing a Draft BO that develops conclusions that constitute a logical outgrowth of information in the report. The Draft BO provides a reasonable evaluation of the best available literature, particularly in the area of estuarine hydrology and geomorphology on which I was asked to focus. I agree with the conclusions in the Draft BO that the Project will have adverse impacts on the threatened CCC steelhead and endangered CCC coho salmon. The Project concludes (p. 206) that "…the proposed project will not adversely affect the abundance and population growth rate of Chinook salmon in the Russian River." Also (p. 207), "we do not expect the project to adversely affect the spatial structure or genetic diversity of the Russian River population of Chinook salmon during the ten years life of the project." To the degree that the project affects estuarine dynamics, these conclusion seem valid. However, these conclusions must be tempered by the uncertainties about the cumulative effects of non-Project changes away from the estuary. While this may be strictly true, one must concede that the project could, in conjunction with non-project impacts, lead to a "tipping point" in Chinook productivity. The success of Chinook will continue to depend on more than just estuarine dynamics. To state that Chinook would not be impacted over the next 10 years because numbers have rise over the past 10 years ignores the work of Lawson (1993) and Gresh et al. (2000) who show how numbers can decline even when habitat is not limited. Montgomery (2004) states:

> habitat availability defines a ceiling for population size, rather than a simple surrogate for population size. Freshwater ecosystems in the Pacific Northwest tend to be nutrient limited and biologists argue that a large modern nutrient deficit in freshwater systems of the Pacific Northwest may limit salmon population size to less than the available habitat could support.

Even though Chinook tend to utilize larger mainstream channels compared to coho and steelhead, these larger streams are susceptible to cumulative impacts. Also, they require deep, sheltered pools in which to rest and clean gravel in which to spawn…critical habitat elements that that could be expected to decline in time with project impacts. Thus, one should be lead one to be more conservative about the likelihood of the Project not adversely affecting Chinook.

Appendix A1. Bibliography of Materials Provided by CIE

Bond, M.H. 2006. Importance of estuarine rearing to central California steelhead (*Oncorhychus mykiss*) growth and marine survival. Masters Thesis. University of California Santa Cruz. 39 pp.

Bush, R.A. 2003. Juvenile steelhead and residence and growth patterns in a California coastal lagoon. Center for Integrated Watershed Science and Management, University of California, Davis.

Cannata, S.P. 1998. Observations of steelhead trout (*Oncorhychus mykiss*), coho salmon (*O. kisutch*) and water quality of the Navarro River estuary/lagoon May 1996 to December 1997. Humboldt State University Foundation. 48 pp, + tables and figures.

Higgins, P. 1995. Fisheries elements of a Garcia River estuary enhancement feasibility study. Mendocino County Resource Conservation District. 22 pp + appendix.

Maahs, M., and S.P. Cannata. 1998. The Albion River estuary, its history, water quality, and use by salmonids, other fish and wildlife species. Prepared for the Humboldt County Resource Conservation District and Coastal Land Trust.

SCWA. 2006a. Russian River estuary fish and macro-invertebrate studies, 2005. Sonoma County Water Agency, Santa Rosa, CA. 35 pp.

SCWA. 2006b. Russian River estuary sandbar breaching 2005 monitoring report. Sonoma County Water Agency, Santa Rosa, CA. 58 pp.

Smith, J. 1990. The effects of the sandbar formation and inflows on aquatic habitat and fish utilization in Pescadero, San Gregorio, Wadell, and Pomponio Creek estuary/lagoon systems, 1985-1089. Department of Biological Sciences, San Jose State University, San Jose, CA. 38 pp + tables and figures.

U.S. Army Corps of Engineers, San Francisco District. 2007. Draft Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers and the Sonoma County Water Agency in the Russian River watershed. National Marine Fisheries Service. June 2007.

Zedonis, P. 1992. The biology of the steelhead (*Oncorhychus mykiss*) in the Mattole River estuary/lagoon. Masters Thesis. California State University-Humboldt.

.

Appendix A2. Bibliography of Other Materials

Armour, Carl L. December 1991. Guidance for evaluating and recommending temperature regimes to protect fish: Instream Flow Information Paper 28. Biological Report 90 (22): 13 pp.

Bilby, R.E., and J.W. Ward. 1989. Changes in characteristics and function of woody debris with increasing size of streams in western Washington. Transactions of the American Fisheries Society 118: 363-378.

Brungs, W.A., and B.R. Jones. May 1977. Temperature criteria for freshwater fish: Protocol and procedures. Environmental Research Laboratory/Office of Research and Development/USEPA.

Burns, J.W. 1970. Spawning bed sedimentation studies in Northern California streams. California Fish and Game 56(4): 253-270.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams, IN Influences of forest and rangeland management on salmonid fishes and their habitats, ed. W.R. Meehan. AFS Special Publication 19: 83-138.

Chapman, D.W. 1988. Critical review of variables used to define effects of fines in redds of large salmonids. Transactions of the American Fisheries Society 117 (1): 1-21.

Cline, S.P., Berg, A.B., and H.M. Wight. 1980. Snag characteristics and dynamics in Douglas-Fir forests, Western Oregon. Journal of Wildlife Management 44 (4): 773-786.

Fausch, K.D., Hawkes, C.L., and M.G. Parsons. 1988. Models that predict standing crop of stream fish from habitat variables: 1950-1985. General Technical Report PNW-GTR-213, USDA Forest Service, Pacific Northwest Research Station: Portland, OR, 52 pp.

Fox, Martin. Muckleshoot Indian Tribe Fisheries Department. June 1994. Memo CESC, CMER concerning the revisions to the WSA Fish Module Diagnostic Matrix and LWD assessment.

Grant, G.E., Swanson, F.J., and M.G. Wolman. March 1990. Pattern and origin of stepped-bed morphology in high-gradient streams, Western Cascades, Oregon. Geological Society of America Bulletin 102: 340-352.

Gregory, S.V. and Bisson, P.A. date? Degradation and loss of anadromous salmonid habitat in the Pacific Northwest. Pages 277-314 in: Stouder, D.J. Bisson, P.A., and R.J. Naiman (eds.), Pacific Salmon and Their Ecosystems: Status and Future Options. Chapman and Hall: New York, NY.

Gresh, T., Lichatowich, J., and Schoonmaker, P. 2000. An estimate of historic and current levels of salmon production in the Northwest Pacific ecosystem: evidence of a nutrient deficit in the freshwater systems of the Pacific Northwest. Fsheries 25(1): 15-21.

Hamilton, K. and E.P. Bergersen. 1984. Methods to estimate aquatic habitat variables. Report prepared for the U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation. Colorado Cooperative Fishery Research Unit, Colorado State University: Fort Collins, CO.

Harvey, B.C., Nakamoto, R.J., and J.L. White. 1999. Influence of large woody debris and a bankfull flood on movement of adult resident coastal cutthroat trout (*Oncorhynchus clarki*) during fall and winter. Canadian Journal of Fisheries and Aquatic Science 56: 2161-2166

Hauer, F.R., Poole, G.C., Gangemi, J.T., and C.V. Baxter. 1999. Large woody debris in bull trout (*Salvelinus confluentus*) spawning streams of logged and wilderness watersheds in northwest Montana. Canadian Journal of Fisheries and Aquatic Science 56: 915-924.

Humboldt State University, Fish, Farm, Forests, and Farms Communities Forum. Simpson Timber Company, National Marine Fisheries Service, Environmental Protection Agency, U.S. Forest Service, and Americorps Watershed Stewards Program. 109 pp.

Keller, E.A., MacDonald, A., Tally, T., and N.J. Merrit. 1985. Effects of large organic debris on channel morphology and sediment storage in selected tributaries of Redwood Creek, northwestern California. U.S. Geological Survey Professional Paper 1454-P.

Keller, E.A., and W.N. Melhorn. May 1978. Rhythmic spacing and origin of pools and riffles. Geological Society of America Bulletin 89: 723-730.

Lake, R.G. and S.G. Hinch. 1999. Acute effects of suspended sediment angularity on juvenile coho salmon (*Oncorhynchus kisutchi*). Canadian Journal of Fisheries and Aquatic Science 56: 862-867.

Lawson, P.W. 1993. Cycles in ocean productivity, trends in habitat quality, and the restoration of salmon runs in Oregon. Fisheries 18(8): 6-10.

Ligon, F., Rich, A., Rynearson, G., Thornburgh, D., and W. Trush. 1999. Report of the scientific review panel on California Forest Practice Rules and salmonid habitat. Prepared for The Resources Agency of California and the National Marine Fisheries Service: Sacramento, CA, 21 pp.

Lisle, T.E., and S. Hilton. April 1999. Fine bed material in pools of natural gravel bed channels. Water Resources Research 35 (4): 1291-1304.

Lotspeich, F.B., and F.H. Everest. January 1981. A new method for reporting and interpreting textural composition of spawning gravel. Research Note PNW-369. Pacific Northwest Forest and Range Experiment Station/Forest Research/USDA.

MacDonald, A. and K.W. Ritland. 1989. Sediment dynamics in type 4 and 5 waters: a review and synthesis. Report prepared for the TFW/CMER Sediment, Hydrology and Mass Wasting Steering Committee and Washington Department of Natural Resources. PTI Environmental Services: Bellevue, WA, 86 pp.

Madej, M.A. 1999. Temporal and spatial variability in thalweg profiles of a gravel-bed river. Earth Surface Processes and Landforms 24: 1153-1169.

McHenry, M.L., Shott, E., Conrad, R.H., and G.B. Grette. 1998. Changes in the quantity and characteristics of large woody debris in streams of the Olympic Peninsula, Washington, U.S.A. (1982-1993). Canadian Journal of Fisheries and Aquatic Science 55: 1395-1407.

Montgomery, D.R. 2004. Geology, geomorphology, and the restoration ecology of salmon. GSA Today 14(11): 4-12.

Montgomery, D.R., Beamer, E.M., Pess, G.R., and T.P. Quinn. 1999. Channel type and salmonid spawning distribution and abundance. Canadian Journal of Fisheries and Aquatic Science 56: 377-387.

Mount, J.F. 1995. California Rivers and Streams. University of California Press: Berkeley, CA, 359 pp.

Nakamura, F. and F.J. Swanson. 1993. Effects of coarse woody debris on morphology and sediment storage of a mountain stream system in western Oregon. Earth Surface Processes and Landforms 18: 43-61.

Nawa, R.K., and C.A. Frissell. 1993. Measuring scour and fill of gravel streambeds with scour chains and sliding-bead monitors. North American Journal of Fisheries Management 13: 634-639.

Newcombe, C.P. and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management 11: 72-82.

Nolan, K.M., Kelsey, H.M., and D.C. Marron (eds.). 1995. Geomorphic processes and aquatic habitat in the Redwood Creek basin, northwestern California. U.S. Geological Survey Professional Paper 1454.

North Coast Regional Water Quality Control Board. August 1993. Testing indices for cold water fish habitat.

Overton, C.K., Wollrab, S.P., Roberts, B.C., and M.A. Radko. 1997. R1/R4 (Northern/Intermountain Regions) fish and fish habitat standard inventory procedures handbook. General Technical Report INT-GTR-346, USDA Forest Service , Intermountain Research Station: Ogden, UT, 73 pp.

Peterson, N.P., Hendry, A., and T.P. Quinn. 1992. Assessment of cumulative effects on salmonid habitat: Some suggested parameters and target conditions. Center for Streamside Studies, University of Washington, Seattle, WA.

Prager, M.H., Spencer, P., Williams, T., Kramer, S., Adams, P. and T. Hablett. 1999. Southwest regional approach to data collection on California coastal salmonids. Report of a workshop, Southwest Fisheries Science Center, National Marine Fisheries Service: Tiburon, CA, 46 pp.

Quninones, R.M. and Mulligan, T.J. 2005. Habitat use by juvenile salmonids in the Smith River estuary, California. Transactions of the American Fisheries Society 134(5): 1147-1158.

Reeves, G.H., Benda, L.E., Burnett, K.M., Bisson, P.A., and J.R. Sedell. 1995. A disturbance-based ecosystem approach to maintaining and restoring freshwater habitats

of extraordinarily significant units of anadromous salmonids in the Pacific Northwest. American Fisheries Society Symposium 17: 334-349.

Richter, D.J. February 1993. Snag resource evaluation (A literature review). Environmental Services Division Administrative Report #93-1. California Department of Fish and Game Timber Harvest Assessment Program.

Richter, D.J., CA Department of Fish and Game. October 1994. Memo to Bill Condon, CA Department of Fish and Game, regarding snag/wildlife tree operational procedures—habitat team assignment.

Rot, B.W., Naiman, R.J., and R.E. Bilby. 2000. Stream channel configuration, landform, and riparian forest structure in the Cascade Mountains, Washington. Canadian Journal of Fisheries and Aquatic Science 57: 699-707.

Sigler, J.W., Bjornn, T.C., and F.H. Everest. 1984. Effects of chronic turbidity on density and growth of steelheads and coho salmon. Transactions of the American Fisheries Society 113: 142-150.

Taylor, R.N. (ed.). 1999. Using stream geomorphic characteristics as a long-term monitoring tool to assess watershed function. Proceedings of a workshop held at

USDA (Forest Service Research/National Forest System). March 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest: The report of the Scientific Analysis Team. Appendix 5-K.

Valentine, B.E. 1995. Stream substrate quality for salmonids: Guidelines for sampling, processing, and analysis: January 4, 1995 Draft. CA Department of Forestry and Fire Protection/Coast Cascade Regional Office, Santa Rosa, CA.

Welsh, H.H., Jr. Roelofs, T.D., and C.A. Frissell. 2000. Aquatic ecosystems of the redwood region. Pages 165-200 in: Noss, R.F. (ed.), The Redwood Forest. Save-the-Redwoods League and Island Press: Washington, D.C., 337 pp.

Ziemer, R.R. (ed.). 1998. Proceedings of the conference on coastal watersheds: the Caspar Creek story. General Technical Report PSW-GTR-168, USDA Forest Service, Southwest Research Station: Albany, CA, 149 pp.

Appendix B. Copy of the Statement of Work

Statement of Work

Assessment of the Estuarine Analysis for the Russian River Water Supply and Flood Control Biological Opinion

Background

The purpose of this independent review is to evaluate and comment on the use of the best available scientific and commercial information in the estuarine-related analysis of the draft (dated June 11, 2007) Biological Opinion (BO) for the Russian River Water Supply and Flood Control Project. It is hoped that this review will help ensure that the best available information is used in this biological opinion. The review will focus on the technical aspects of the estuarine-related portions of the NMFS draft biological opinion; the review will not determine if NMFS conclusions regarding the project's potential to adversely modify critical habitat or jeopardize the continued existence or recovery of listed salmonids are correct.

The Southern and Central Coastal sections of California have a Mediterranean climate that significantly affects physical and water quality dynamics of estuaries. A combination of ocean wave action and the absence of significant rainfall between late May and early November contribute to the formation of closed, freshwater lagoons at river mouths. Wave action builds up sandbars at river mouths; low summer inflow to the lagoons percolate through the bar, thus maintaining closed freshwater systems. Limited research indicates that, in this region where summer flows in headwaters are naturally very low, freshwater lagoons provide highly productive and important rearing habitats for steelhead (*Oncorhynchus mykiss*) and possibly Chinook salmon (*O. tshawytscha*).

The ongoing and proposed operations of the Russian River reservoirs cause sustained, unnaturally high flows to the estuary from approximately May through early November. During this period, the elevated flows can cause natural bar breaching at the river's mouth, with resulting water quality cycles that can be deleterious to juvenile salmonids. The elevated summer inflows also contribute to high water surface elevations that threaten to flood a few properties bordering the Russian River estuary. Project operators address the potential threat of property flooding by breaching bars that form at the river's mouth, thereby maintaining the estuary as an open system with nearly marine conditions in the middle and lower segments of the system.

In conducting Section 7 consultations, NMFS is obligated to use the best scientific and commercial data available to evaluate whether projects jeopardize the continued existence of species listed under the Endangered Species Act. However, for such analyses, NMFS is not obligated to independently develop new scientific data. NMFS Draft BO for the Russian River Water Supply and Flood Control Project reviewed scientific literature concerned with the role of small estuaries and freshwater lagoons as

rearing habitat for steelhead. Information on estuarine use and population dynamics of steelhead and other salmonids in Mediterranean climates is very limited; most is from unpublished manuscripts and graduate theses. Most published information on steelhead use of estuaries is based on populations from more northerly regions where year-round rainfall supports relatively high summer flows and rearing habitat in upland watersheds. NMFS Draft BO directly addresses estuarine issues in three separate sections: the Baseline (Section V., pp 82-83, 92-94, 98, and 102), the Effects (Section VI.G), and the Integration and Synthesis (Sections VIII.A.2, and VIII. B.2).

Fundamental Questions for the CIE reviewers

- Does the site specific data for the Russian River, referenced supporting literature, and analysis in the Draft BO provide reasonable support for the conclusion that the regulated elevated inflows and systematic artificial breaching of the Russian River estuary collectively cause an adverse effect on rearing habitat for steelhead in the lower Russian River (*i.e.*, in the estuary/potential lagoon system)? If not, what relevant scientific information should be considered?

- Were relevant published and unpublished studies on the relative productivity of freshwater lagoons and estuaries and the use of freshwater lagoons by steelhead and other salmonids missed? If so, what key studies were missed?

- The Draft BO states on page 172 that the "systematic breaching of the estuarine bar reduces the estuary's carrying capacity for juvenile steelhead". Is this a reasonable and adequately supported statement?

- What uncertainties related to the estuarine analysis were not addressed that might affect the BO substantively?

General Requirements

The CIE shall provide three independent scientists for this review. Expertise is required in anadromous salmonid biology and ecology, hydrology, and the ecology of estuaries in Mediterranean climates (*i.e.,* estuarine systems that periodically form freshwater lagoons during the low flow season). No consensus opinion among the CIE reviewers is sought.

The activities required under this Statement of Work shall be conducted electronically, so no travel is needed.

CIE reviewers shall review the following document which is the focus of the questions listed above:

- Draft Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers and

the Sonoma County Water Agency in the Russian River watershed. National Marine Fisheries Service. June 2007.

To aid the reviewers, we are providing copies of the following unpublished manuscripts cited in NMFS BO:

1. SCWA. 2006. Russian River estuary fish and macro-invertebrate studies, 2005. Sonoma County Water Agency, Santa Rosa, CA. 35 pp.

2. SCWA. 2006. Russian River estuary sandbar breaching 2005 monitoring report. Sonoma County Water Agency, Santa Rosa, CA. 58 pp.

3. Smith, J. 1990. The effects of the sandbar formation and inflows on aquatic habitat and fish utilization in Pescadero, San Gregorio, Wadell, and Pomponio Creek estuary/lagoon systems, 1985-1089. Department of Biological Sciences, San Jose State University, San Jose, CA. 38 pp + tables and figures.

4. Higgins, P. 1995. Fisheries elements of a Garcia River estuary enhancement feasibility study. Mendocino County Resource Conservation District. 22 pp + appendix.

5. Cannata, S.P. 1998. Observations of steelhead trout (*Oncorhychus mykiss*), coho salmon (*O. kisutch*) and water quality of the Navarro River estuary/lagoon May 1996 to December 1997. Humboldt State University Foundation. 48 pp, + tables and figures.

6. Maahs, M., and S.P. Cannata. 1998. The Albion River estuary, its history, water quality, and use by salmonids, other fish and wildlife species. Prepared for the Humboldt County Resource Conservation District and Coastal Land Trust.

7. Zedonis, P. 1992. The biology of the steelhead (*Oncorhychus mykiss*) in the Mattole River estuary/lagoon. Masters Thesis. California State University-Humboldt.

8. Bush, R.A. 2003. Juvenile steelhead and residence and growth patterns in a California coastal lagoon. Center for Integrated Watershed Science and Management, University of California, Davis.

9. Bond, M.H. 2006. Importance of estuarine rearing to central California steelhead (*Oncorhychus mykiss*) growth and marine survival. Masters Thesis. University of California Santa Cruz. 39 pp.

The above material will be provided by the NMFS Southwest Regional's (SWR) contact persons: Dick Butler Dick.Butler@noaa.gov and Bill Hearn William.Hearn@noaa.gov

Each reviewer's duties shall not exceed a maximum total of 10 days – approximately 5 days for report and literature review and 5 days to produce a written report of the findings. Each reviewer may conduct their analyses and writing duties from their primary work location. Each report is to be based on the individual reviewer's findings, and no consensus report shall be accepted.

The itemized tasks of each reviewer consist of the following.

4. Read the draft Russian River Biological Opinion with a focus on the estuarine component of the analysis.

5. Consider additional scientific information as necessary.

6. No later than February 15, 2008, each CIE reviewer shall submit their independent peer-review report addressing each task in this Statement of Work to Dr. David Die at ddie@rsmas.miami.edu and Mr. Manoj Shivlani at mshivlani@rsmas.miami.edu

Submission and Acceptance of CIE Reports

No later than February 29, 2008, the CIE shall provide via e-mail the final independent CIE reports and the CIE chair's summary report to the COTR William Michaels (William.Michaels@noaa.gov) at NOAA Fisheries. The COTR and alternate COTR Dr. Stephen K. Brown (Stephen.K.Brown@noaa.gov) will review the CIE reports to determine that the Term of Reference was met, notify the CIE program manager via e-mail regarding acceptance of the reports by December 30, 2007, and then distribute the reports to the SWR contact person.

ANNEX I: REPORT GENERATION AND PROCEDURAL ITEMS

1. The report shall be prefaced with an executive summary of comments and/or recommendations.

2. The main body of the report shall consist of a background, description of review activities, summary of analyses and comments, and conclusions/recommendations.

3. The report shall also include as separate appendices the bibliography of materials reviewed and a copy of the statement of work.

Please refer to the following website for additional information on report generation: http://www.rsmas.miami.edu/groups/cimas/report_Standard_Format.html